U.S. DEPARTMENT OF AGRICULTURE Miscellaneous Publication No. 1082

RESTORING SURFACE-MINED LAND

TYPES OF SURFACE MINING

OPEN PIT.—Excavating for stone, sand and gravel, iron, or copper where a mineral deposit is found within a small area. Most quarries fall under this category. Some of these mines may be operated in one location for many years.

AREA STRIPPING.—Digging a series of parallel trenches in relatively flat or rolling terrain to get coal, phosphate, or other minerals. Spoil material is placed in the previous cut made; the mine resembles the ridges of a washboard with an open trench where the last cut was made.

CONTOUR STRIPPING.—Digging around a hillside in steep or mountainous country, usually for coal. It creates a shelf or "bench" bordered on the inside edge by a high wall that may be as much as 100 feet tall and on the outside edge by a rim and a very steep "outslope" covered by loose spoil material.

AUGER MINING.—Boring horizontally into a seam to get more coal after stripping is finished. A cutting head—as large as 7 feet in diameter—is drilled into the seam, and coal is scraped out along the auger threads.

DREDGING.—Removing sand and gravel, gold or other minerals from underwater or low-lying areas by a suction pump or digging device usually mounted on a floating barge. Spoil piles may resemble those from area stripping.

HYDRAULIC MINING.—Using a powerful jet of water to wash down or erode a bank to get gold or other precious metals. Ore is separated by differences in specific gravity as the material is fed through sluices or other devices.

Contents

The U.S. Department of Agriculture was represented on the study of surface mining required in Public Law 89–4 by Darnell M. Whitt, Soil Conservation Service, and Byron Beattie, Forest Service, members of the working committee. Theodore B. Plair, Soil Conservation Service, and Edward A. Johnson, Forest Service. were participating staff members.

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RESTORING SURFACE-MINED LAND

By the U.S. Department of Agriculture

Introduction

A power shovel as big as an office building bites into the earth, piling up row on row of rock and soil to get at a vein of coal . . . .

An auger with a 7-foot bit bores into a hillside, and coal works its way out like wood shavings . . . .

A floating barge dips its big chain-bucket into a streambed for a load of sand and gravel . . . .

An ore-laden train snakes its way out of a giant open pit . . . .

Through these and other operations man carries on the big activity of surface mining. He gets many minerals, fuels, and building materials that help our Nation grow and that provide jobs in rural America (table 1).

In the process, the land is changed—laid bare, rearranged into parallel ridges, or scooped out like a soupbowl. Properly treated and managed, it can be returned to safe and productive use, even become a greater asset to the community than it was before mining. Left alone, it may produce only

With today's large excavating equipment we can not only surface mine faster and cheaper but also reshape the landscape and rehabilitate the site easier.

TABLE 1.—*Land disturbed by strip and surface mining in the United States, by commodity, Jan. 1, 1965* [1]

[In thousands of acres]

Mineral	Strip mining			Into hillside	Quarry-open pit below ground level	Total	Dredge, hydraulic, and other methods	Grand total [2]
	Contour	Area	Total					
Coal [3]	665	637	1,302					1,302
Sand and gravel	38	258	296	82	371	453	74	823
Stone	6	8	14	100	127	227		241
Gold		8	8	1	3	4	191	203
Clay	10	26	36	22	44	66	7	109
Phosphate	28	49	77	13	93	106		183
Iron	7	31	38	30	96	126		164
All other	11	12	23	59	81	140		163
Total	765	1,029	1,794	307	815	1,122	272	3,188

[1] Acreage by method of mining estimated from random sampling survey.

[2] Compiled from data supplied by U.S. Department of the Interior; from Soil Conservation Service, U.S. Department of Agriculture; and from estimates prepared by the field study group.

[3] Includes anthracite, bituminous, and lignite.

stream-fouling sediment and acid and ugliness.

For many years the U.S. Department of Agriculture (USDA) has been helping private-land owners restore their surface-mined land as part of their regular programs of wise land use and conservation treatment. USDA also has done restoration work and research studies on the public land it administers. Its experience and skills range all the way from preplanning mining to prevent offsite damage to development of a mined area for highly intensive uses.

Through studies and experience and through participation in the 2-year National Surface Mine Study under Public Law 89–4, USDA has gathered a great deal of information about surface-mined-land conservation progress and needs. In this report highlights of the data are given as well as ideas for future action, suggested by research and experience, that can speed restoration of the surface-mined land that is intermingled with farm, ranch, forest, and other land in rural and suburban America.

SURFACE-MINED LAND—BY STATES.—An estimated 4 million acres of land—some in every State—had been disturbed by surface mining by January 1, 1972 (table 2).

DISTANCE FROM POPULATION CENTERS.—Surface-mined-land conservation is a *rural* opportunity. More than four-fifths of the mined land surveyed is at least a mile from communities with a population of more than 200. More than half are more than 4 miles from town. And 40 percent of the mined land cannot now be seen from any U.S. highway or passenger railroad. Most areas were close enough to communities, though, for a family to reach for an afternoon recreation outing. No urban growth was evident around two-thirds of them, which suggests that these areas are likely to continue in agricultural and related uses.

OWNERSHIP.—Ownership of the land and its minerals holds the key to use and conservation of these resources. Since most surface-mined land is privately owned, opportunity for improvement lies largely in local assistance programs of mutual interest and value to landowners and their neighbors—the kind of program already being carried on by the Nation's 3,000 soil and water conservation districts and by State forestry agencies with USDA help. Increased assistance through these going programs could do the job. And since the mining industry owns more than half of the surface-mined land, it has a challenge to restore its property to a useful state and to prevent offsite damages.

A survey of 693 surface-mine sites [1] in 1966 showed that many were scattered small acreages best treated as part of the total conservation management of the farm and other areas with which they are intermingled. Nearly 80 percent of the sites were in forest, farm, or grassland or reverting to forest at the time of survey. These same uses were being made of land adjacent to 86 percent of the sites. Less than 2 percent of the acreage had

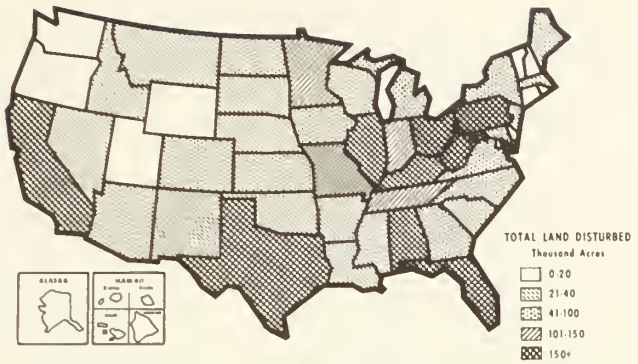
[1] Sites were selected at random from mined land throughout the Nation to represent the surface-mining situation. Of the total, 180 sites were mined for coal; 149 for sand and gravel; 100 stone; 49 clay; 49 iron; 48 gold; 40 phosphate; and 78 for eight other commodities.

TABLE 2.—*Status of land disturbed by surface mining in the United States as of January 1, 1972, by State* [1]

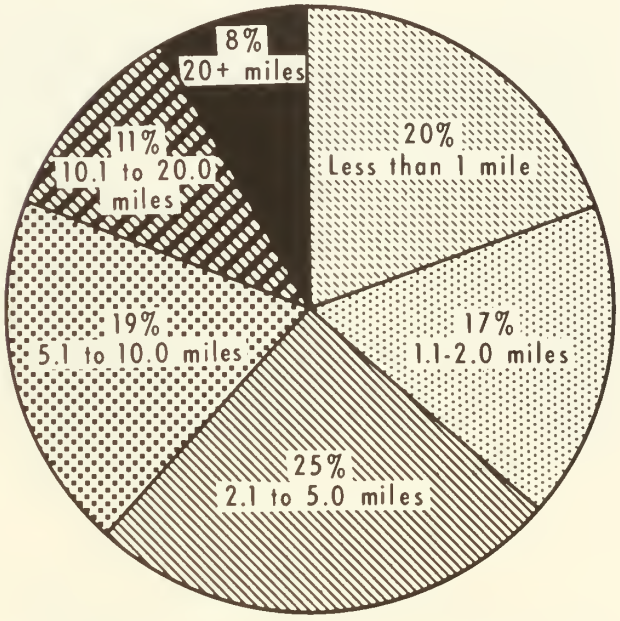
[In thousands of acres]

State	Land requiring reclamation	Land not requiring reclamation	Total land disturbed
Alabama	127. 9	43. 1	171. 0
Alaska	4. 4	6. 7	11. 1
Arizona	29. 7	28. 3	58. 0
Arkansas	17. 1	6. 6	23. 7
California	69. 7	109. 5	179. 2
Colorado	41. 3	14. 8	56. 1
Connecticut	12. 2	5. 1	17. 3
Delaware	2. 2	1. 9	4. 1
Florida	196. 0	58. 8	254. 8
Georgia	28. 1	13. 1	41. 2
Hawaii	0. 1	0. 1	0. 2
Idaho	16. 0	8. 1	24. 1
Illinois	66. 3	102. 2	168. 5
Indiana	25. 0	120. 7	145. 7
Iowa	32. 4	18. 3	50. 7
Kansas	67. 4	13. 5	80. 9
Kentucky	58. 0	187. 4	245. 4
Louisiana	26. 4	9. 8	36. 2
Maine	26. 4	13. 2	39. 6
Maryland	25. 0	12. 7	37. 7
Massachusetts	30. 7	17. 8	48. 5
Michigan	72. 4	22. 0	94. 4
Minnesota	52. 6	72. 7	125. 3
Mississippi	22. 0	10. 3	32. 3
Missouri	93. 9	18. 5	112. 4
Montana	22. 0	9. 3	31. 3
Nebraska	12. 5	10. 5	23. 0
Nevada	21. 7	12. 7	34. 4
New Hampshire	4. 4	4. 3	8. 7
New Jersey	17. 6	10. 8	28. 4
New Mexico	13. 3	8. 8	22. 1
New York	40. 0	18. 0	58. 0
North Carolina	27. 1	15. 7	42. 8
North Dakota	27. 5	17. 1	44. 6
Ohio	191. 6	162. 1	353. 7
Oklahoma	5. 0	25. 0	30. 0
Oregon	6. 6	2. 8	9. 4
Pennsylvania	240. 9	201. 5	442. 4
Rhode Island	2. 6	1. 2	3. 8
South Carolina	20. 0	15. 0	35. 0
South Dakota	16. 0	18. 2	34. 2
Tennessee	40. 0	78. 9	118. 9
Texas	136. 8	34. 0	170. 8
Utah	3. 4	2. 8	6. 2
Vermont	4. 2	2. 6	6. 8
Virginia	33. 0	48. 8	81. 8
Washington	5. 5	3. 6	9. 1
West Virginia	100. 0	170. 9	270. 9
Wisconsin	35. 3	27. 2	62. 5
Wyoming	11. 0	6. 7	17. 7
Total	2, 181. 2	1, 823. 7	4, 004. 9

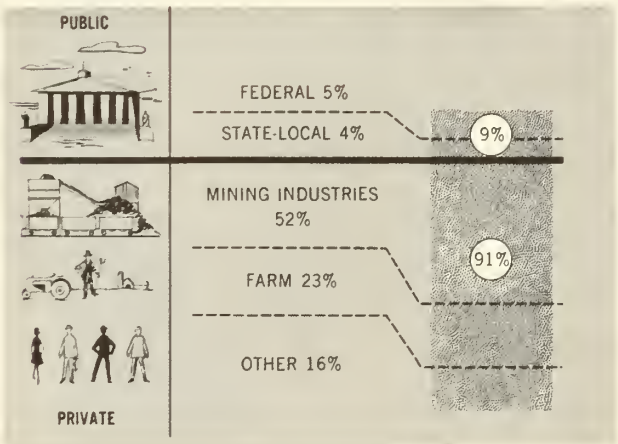
[1] Compiled from estimates provided by State offices of the Soil Conservation Service, USDA, September 1972.



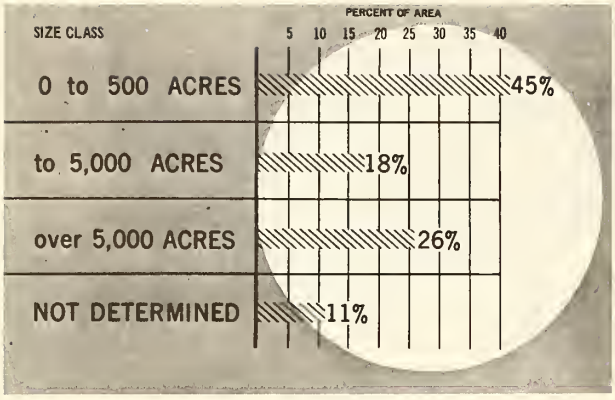
Surface-mined land—by States.



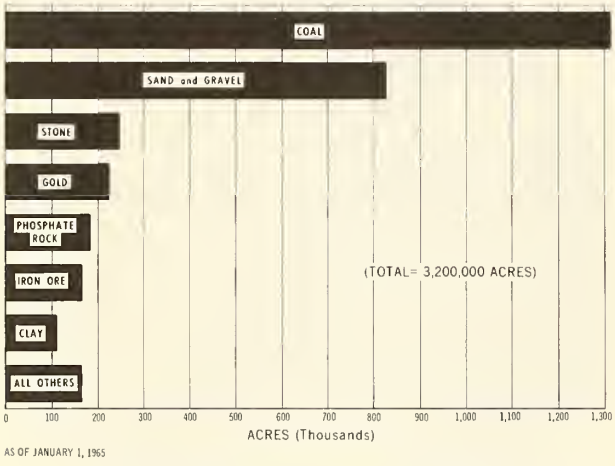
Proximity of surface-mined areas to population centers.



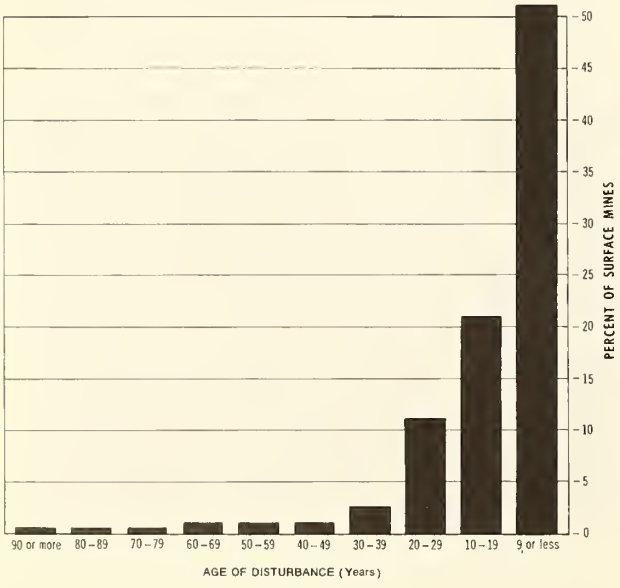
Ownership of surface-mined land.



Small ownerships predominate.



Surface-mined land—by commodities.



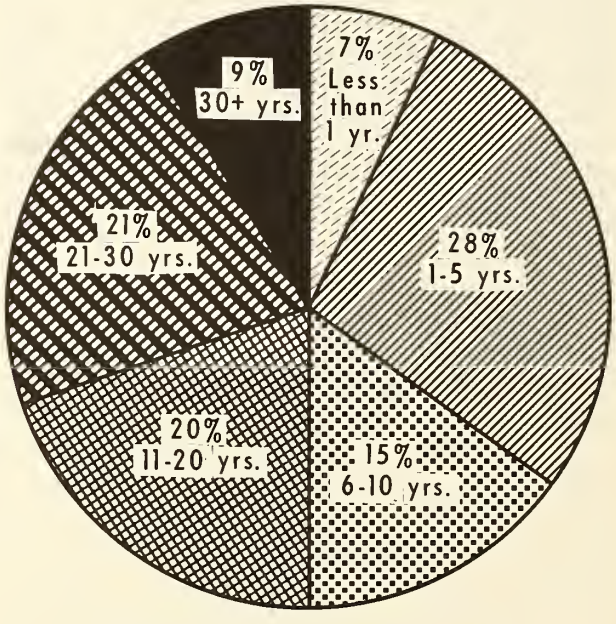
Age of surface mines.

been set aside solely as outdoor recreation or wildlife areas; usually these are compatible with other uses of the land.

SURFACE-MINED LAND—BY COMMODITIES.—More than 50 minerals are produced by surface mining in the United States. About 95 percent of the acreage disturbed by 1965 was for seven commodities: Coal, about 40 percent; sand and gravel 25 percent; stone, gold, clay, phosphate, and iron 30 percent. On two-thirds of the areas surveyed, the mineral deposit being mined was over 9 feet thick. This means great value from an acre but difficulty in reshaping the land to its original contours. Grading enough to satisfy intended land use is more practical. Some thin deposits might better have been left unmined where restoration costs would be proportionately high.

AGE OF SURFACE MINES.—Of the 693 sites sampled in 1966, 10 were mined more than a century ago. But most spoil banks and other disturbances are less than 10 years old, indicating a rapid rise in surface-mining activity. The acreage mined has more than doubled in the last 20 years.

DURATION OF SURFACE MINING.—Half of the sites sampled were quarries or pits that had been operated for more than 10 years. Only a third of the sites had been operated for less than 5 years. Most were active long enough to have a significant economic impact on the community, and usually other surface-mining operations began later within the same watershed or drainage area.



Duration of surface mining in years.

Where storm-water control is inadequate, surface-mine spoils and the community may be damaged.

Characteristics and Physical Condition

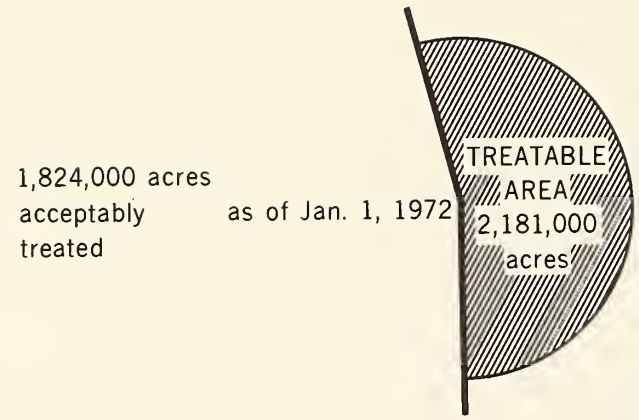
Of the 4 million acres disturbed by surface mining, about half needs no further treatment to prevent sediment or other damage to adjacent land and water. About 46 percent of these 1.8 million acres that need no treatment was stabilized by nature over a period of years; 51 percent was treated through efforts of the mining industry and individual landowners; and the rest was treated by government at some level.

On the other two-thirds, newness of the disturbed area, distance from natural seed sources, or other problems make establishment of protective plants slow or difficult. Steep or unstable slopes, acidity, or stoniness are problems in some areas. These are susceptible—in varying degrees—to erosion and may contribute sediment and other pollutants to streams that drain them.

Spoil banks

In surface-mining operations the layers of soil and rock above the mineral deposit are shoveled out and piled up in "spoil" banks. These banks are a mixture of soil, subsoil, and unweathered rock that is far from resembling a soil formed in nature. Their characteristics vary greatly among mines, and even within the same mine. Prediction of site suitability thus is best done with the help of professional soil scientists, agronomists, foresters, and other specialists.

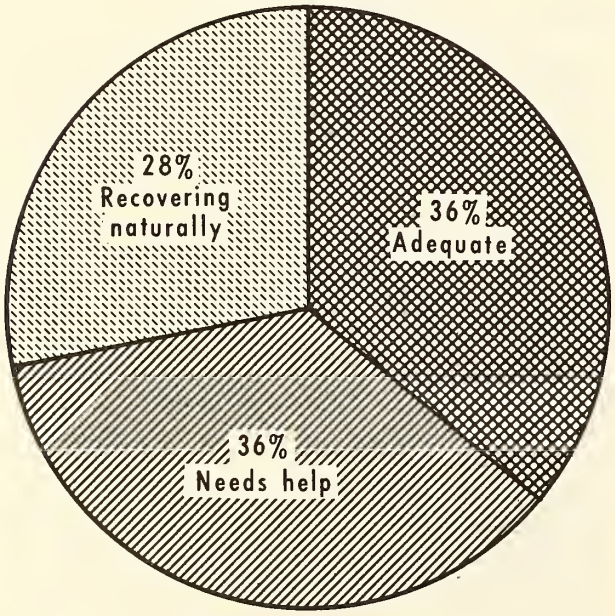
TEXTURE.—Spoil texture influences the amount of moisture available for plant growth. In general, spoil composed largely of sand has good aeration but is apt to be droughty. Clay banks compact easily and crust over during dry periods. Loams and silty shales usually have enough fine material to hold moisture. On about 80 percent of the surface-mined land, spoil texture is adequate for growing adapted grasses and legumes for quick erosion control and to supplement tree or shrub



Area acceptably treated.

plantings. Rock content on about three-fourths of the banks, however, restricts the type of equipment that can be used in revegetation. On about one-fourth of the banks the spoil is suitable for farm crops.

ACIDITY.—Acid problems are associated largely with coal mining. They are caused when minerals left exposed to air and water react to form toxic or corrosive substances.



Cover conditions.

By itself, acidity does not directly influence plant growth. But it affects the availability of soil nutrients—dissolved minerals—and the number of soil micro-organisms. Strongly acid soils may, however, dissolve enough elements to injure or destroy plants that absorb them. More than half of the sites have acid soils; 20 percent are acid enough to be a limiting factor in establishing plant cover; only 1 percent is so acid that plants will not grow. Acidity usually is reduced through weathering and leaching of the acid-forming materials.

SLOPES.—More than 2 million acres (about 75 percent) have been mined on areas with original slopes of less than 20 percent—in the small watershed projects with which USDA has been working most of the mined areas have slopes of less than 10 percent. Only about 8 percent of the mined areas were on hillsides with slopes of more than 40 percent.

Four-fifths of the affected areas were on side slopes, ridgetops, or isolated knobs from which storm-water flows need to be guided into defined stream channels—with grass waterways or chutes, for example. The other one-fifth were on valley floors close to rivers and subject to local flooding.

Climate

About four-fifths of the surface-mined land is in areas where rainfall and temperatures are adequate for plant growth. With adequate spoil conditions and proper preparation, plant establishment and growth should be possible. On the other one-fifth, plants grow slowly because of too little or too much moisture, high temperatures, or unfavorable evapotranspiration ratio. Here special treatments and plants are needed to offset poor ecological conditions.

Erosion

About 2 million acres have evidence of sheet erosion. Some erosion is inevitable on fresh spoil banks, as it is on any bare soil. How severe it is depends on steepness and length of slope, extent of freezing and thawing, amount and intensity of precipitation, and how water is concentrated on the spoil. Thus, the quicker a plant cover is established to protect against erosion the better.

Forty percent or 1.2 million acres have eroded enough to form rills and small gullies. On 12 percent or 400,000 acres, gullies more than a foot deep have formed; these seem to be associated with long slopes created by grading.

Sheet erosion is not a serious problem in either area stripping or dredging since most of the soil

movement is between spoil banks and little leaves the mine area. Sheet erosion is more serious in contour stripping.

Erosion danger is greatly increased at the point where storm water drains from a surface mine because of the concentrated force of water.

SLIDES.—On about 3,600 miles of slopes left by contour and area stripping (called outslopes), massive slides are a problem—especially where the subsoil is unstable. Slides may enter streams and even block channels. Their stabilization or removal would be costly and would involve geology, soils, engineering, hydrology, and forestry skills. Slides of this size occur on about 10 percent of the total mileage of outslopes.

ACCESS ROADS.—Mining haul roads are responsible for much erosion, especially in mountain areas. About 1,650 miles of these roads have eroded so badly they need major repairs. Another 3,300 miles are moderately eroded. Access roads for most mines surveyed were under 7 miles in length, and many were of half a mile or less. Many would best be revegetated rather than kept as roads. The rest need careful management after hauling stops.

Plant cover

For newly mined land, the great need is to establish plant cover as quickly as possible. Adequate plant cover reduces erosion and siltation in almost all cases, but it takes time. There is no "instant cover." Examination of sites capable of supporting vegetation showed that 36 percent had plant cover of 40 percent or more. About 28 percent of the sites had less than 40 percent cover at the time but, in the judgment of the survey team, would develop adequate protective cover naturally in time. The other 36 percent of the sites will require seeding, planting, fertilizing, and other attention to develop adequate protective cover.

It was estimated that three-fourths of the vegetation had occurred naturally on ground with more than 10 percent plant cover, and one-fourth through the efforts of man. Variations in vegetation appear to be associated with climatic conditions, spoil characteristics, nearness to natural seed sources, and age of the spoil banks. Half of the banks are less than 10 years old.

Water quality and streamflow

Surface mining in some areas is a source of water pollution, mainly sediment and to a less extent acid. Of the sites surveyed, 56 percent showed no pollution; 23 percent showed some intermittent pollution; and 21 percent produced considerable pollution. The survey team estimated that about a third of the surface-mined land needing conservation treatment, or about 665,000 acres, needed some action to reduce offsite water pollution.

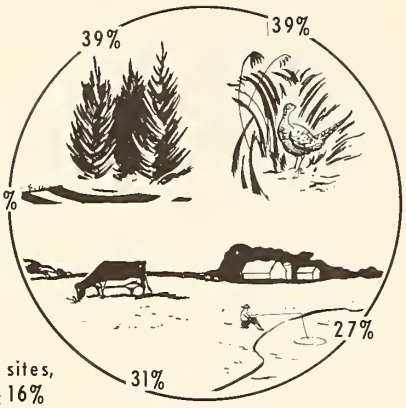
Of the streams receiving direct runoff from surface-mined sites, 31 percent of those examined contained noticeable amounts of mineral precipitates. Water discoloration, suggesting chemical or physical pollution, was noted in 37 percent of the streams. Natural seepage from unworked coal and other pyritic material—from both surface and deep mines—causes limited local pollution. Access roads built of pyritic waste material also may be sources of acid water.

Sediment is a problem where inadequate plant cover permits erosion and water is allowed to run off the site from roads, terrace outlets, outslopes, or slides. It is particularly severe in areas of high-intensity storms and steep slopes.

Sediment generally was not present in small streams more than 2 miles from the mine area. But of 14,000 miles of stream channels affected by surface mining, half have had their water-carrying capacity reduced; along 4,500 miles capacity was moderately reduced, and along 2,500 miles capacity had been affected only slightly.

Self-contained mining sites—quarries, dredged areas, and some area-stripped sites—do not have enough runoff to warrant costly storm-water controls. Contour-stripped areas can be used to manage runoff in much the same way as broad-based

Stream capacity reduced by sediment from surface-mining operations.



Wildlife habitat 39%
Posture-ronge 31%
Forest 39%
Farm and forest recreation 27%
Cultivoted 3%
Miscelloneous (building sites, woter surfoces, etc.) 16%

Note: Total exceeds 100%. Some areas ore used for more than one purpase.

Potential uses of surface-mined land.

terraces. But on 98 percent of the surface-mined land studied in Appalachia—where most contour stripping is done—storm-water runoff control was not adequate to prevent erosion, sediment, or flooding.

On these areas, vegetative and mechanical measures or a combination are needed. An example is the need for grading within some surface-mine pits to control storm runoff. About 75 percent of the sites need some grading, and only 45 percent have received any. Grading too much or on the wrong soil material, though, may make matters worse; special care and technical assistance are needed. In some areas of the West, minor reshaping of some banks is adding to the beauty of the landscape.

Ponds

Many surface-mined areas have ponds or depressions, especially where area stripping has been done. Forty-two percent of the ponds are smaller than an acre, 40 percent are 1 to 10 acres, and 18 percent are larger than 10 acres. Two-thirds are more than 5 feet deep.

Acidity is a problem in some ponds—one-fifth of those studied had a pH rating of less than 4.5. The other four-fifths are less acid and include the larger and deeper ponds that have greater potential use. Some are being used even for municipal water supplies.

Animal life was present in four-fifths of the ponds, but scarce in the acid ponds.

Effect on wildlife

Disturbing land and water for mining naturally disrupts wildlife habitat. State fish and game commissions reported to U.S. Bureau of Sport Fisheries and Wildlife that nearly 2 million acres of wildlife habitat had been damaged by surface mining—68 percent of it east of the Mississippi River. Most damage resulted from:

- Stream widening, affecting water temperature and depth of spawning beds.
- Lake draining.
- Burying or removing spawning gravels.
- Diverting surface flow.
- Sediment.
- Chemical changes in soil and water quality.
- Removing food, nesting, and escape cover plants.
- Forming high walls that limit animal access or movement (a problem on about one-fourth of the high wall mileage studied).

Where proper restoration measures have been taken, fish and wildlife habitat has improved and often is better than before mining. Since the same kinds of wildlife use the mined site and adjacent land, there is opportunity for managing both areas together for wildlife habitat on private and public property.

Safety

One-third of the mined areas studied had some safety hazard, usually water. On 22 percent of the inactive areas there was evidence of abandoned buildings, equipment, debris, or rubble—some hazardous and nearly all unsightly. Ten percent had one or more deep-mine openings—without shaft sealing. Restoration measures, well planned and carried out, reduce the danger to public safety.

Properly treated and managed surface-mined areas can help meet growing needs for outdoor relaxation.

A 4-year-old shortleaf pine plantation on surface-mined land.

Accomplishments

USDA's participation in surface-mined-land conservation began in the 1930's. The Forest Service then began research on revegetating mined land and keeping acid and sediment out of streams. The Soil Conservation Service at the same time began helping landowners improve their soil and water resources and solve many land use and land treatment problems, among them surface mining.

During one 7-year period, 1965–71, more than 10,000 land owners and operators in 1,336 local soil and water conservation districts in 45 States applied conservation measures to nearly 338,000 acres of surface-mined land with USDA help (table 3). The survey team noted that the conservation districts considered restoration of mined areas as part of the total conservation job on individual properties or whole watersheds and not a separate or special activity.

During the 5-year period 1960–64, State foresters, through Federal-State cooperative programs, provided technical help to more than 1,250 ownerships in replanting about 37,000 acres to trees.

Industry

Many mining firms are giving increased attention to the challenge of surface-mined-land con-

servation. Reclamation associations formed in a number of States have their own professional staff to foster restoration work. Individual firms and their associations have restored many mined acres, conducted demonstration projects and experimental plantings, carried on substantial research work, and in general promoted effective conservation treatment of surface-mined land.

TABLE 3.—*Mined land reclaimed by cooperators with conservation districts, 1965–71* [1]

State	Cooperators	Area
	Number	*Thousand acres*
Alabama	205	43. 1
Arizona	11	4. 2
Arkansas	14	. 5
California	58	7. 5
Colorado	68	2. 3
Connecticut	14	. 3
Delaware	28	. 8
Florida	20	12. 5
Georgia	169	4. 9
Idaho	60	1. 9
Illinois	120	31. 1
Indiana	223	20. 4
Iowa	169	3. 5
Kansas	371	4. 3
Kentucky	377	14. 9
Louisiana	141	1. 3
Maine	100	. 7
Maryland	139	3. 7
Massachusetts	200	2. 5
Michigan	274	2. 5
Minnesota	121	6. 4
Mississippi	34	2. 0
Missouri	50	1. 5
Montana	150	1. 6
Nebraska	240	5. 4
Nevada	2	. 3
New Hampshire	50	. 2
New Jersey	18	. 8
New Mexico	19	. 5
New York	86	1. 2
North Carolina	173	1. 7
North Dakota	375	2. 5
Ohio	350	10. 5
Oklahoma	10	1. 5
Oregon	30	. 2
Pennsylvania	500	28. 0
Rhode Island	3	0
South Carolina	6	. 8
South Dakota	700	1. 0
Tennessee	213	9. 1
Texas	1, 394	13. 1
Utah	8	. 3
Virginia	100	26. 0
Washington	1	0
West Virginia	2, 500	55. 2
Wisconsin	314	4. 7
Wyoming	10	. 5
Total	10, 218	337. 9

[1] Data compiled by Soil Conservation Service, USDA, September 1972.

To speed the restoration job, professional assistance is needed in classifying spoil banks and interpreting the data for various land uses.

Properly selected and planted, trees can aid in stabilizing a mined area and increase its usefulness.

For example, reclamation associations in the Appalachian region have done reforestation and seeding on 74,000 surface-mined acres. The National Sand and Gravel Association's members rehabilitated 52 percent of the acreage they mined in 1965, compared with only 25 percent just 2 years earlier. Phosphate mining firms in Florida, between 1961 and 1966, voluntarily restored 75 percent of the acreage mined during that period. Where mines are near urban areas, many phosphate miners have made plans *before mining* for later development of the site as residential, commercial, or recreation areas. And the National Coal Association, with operator members in 21 States, promotes restoration of mined land for useful purposes.

Many other firms and commodity groups have yet to follow these examples and respond to the challenge of surface-mined-land conservation.

Research

USDA is the recognized leader in basic research on surface-mined-land conservation. Most research now underway in government and industry is in six categories:

(1) *Revegetation*—developing plant species that will provide quick cover or permanent growth and comparing various combinations of seedings.

(2) *Chemistry of overburden and spoils*—identifying soil and rock mixtures, soil and water characteristics, and effects of fertilization and weathering.

(3) *Hydrology*—studying water and drainage effects, sedimentation, and ground-water movement and storage.

(4) *Earth movement and placement*—finding new or adapted equipment and methods for mining and more economical restoration.

Water is a natural companion to surface-mined areas. Planning for its collection, control, and storage can enhance the usefulness of the site and reduce offsite damages.

(5) *Haul roads*—designing better and safer access roads as well as better hauling equipment.

(6) *Land use potentials*—making guidelines for finding the best use for a mined area consistent with the community land use pattern and needs, characteristics of the mined land, and cost-return factors.

There are many areas of study in which more research is needed to improve both surface mining and the reuse of the mined areas:

Comprehensive knowledge of physical and chemical characteristics of spoil materials is needed, as well as interpretations or ratings of surface-mined-areas land use potentials or limitations.

Better methods are needed for lifting, moving, piling, and relocating overburden, especially on sloping land.

More knowledge is needed about the responses of many different plants and about their usefulness for landscaping, screening, protective cover, wildlife habitat, and soil building.

Improved methods of preparing surface and subsurface water storage are needed to make effective onsite water use and prevent pollution and excess runoff.

Potential and challenge

Properly planned, treated, and developed to blend with adjacent land use patterns, most surface-mined areas have great potential (table 4). Thirty-two percent of the areas surveyed provide an outstanding view of mountains, valleys, or lakes. Haul roads can open up many areas to visitors for the first time. Ponds can give an area greater economic value than it had before mining. And most areas can be kept in private ownership.

Attention must be given to today's growing land use demands. The challenge to USDA is to assist in developing resource uses in surface-mined areas that will be compatible with one another and with uses of adjacent land.

A similar challenge is to make sure that the optimum benefit—both to the landowner and the community—is derived from each dollar spent in mining and land restoration. Some shallow deposits would better be left unmined where restoration costs would be prohibitive. Some mined sites would best be treated to prevent offsite damage but not developed. In some areas, mined land can be treated and managed for intensive use.

TABLE 4.—*Potential multiple and alternative uses of surface-mined areas in several States* [1]

[In percent]

State	Cropland	Pasture land	Rangeland	Woodland	Wildlife habitat	Ponds and reservoirs	Farm and forest recreation	Residential, institutional, industrial	Other unspecified
Arizona	0.5	0.5	19.7	0.2	17.6	2.4	9.6	6.4	49.8
Arkansas	.3	6.2	14.7	44.4	15.5	10.0	6.8	1.1	1.3
California	.5	8.6	26.9	17.8	62.5	5.2	46.2	10.4	7.3
Florida	2.8	10.8	42.6	48.4	46.6	14.9	53.2	6.1	3.7
Illinois	15.2	49.6	.9	27.3	31.8	9.0	28.9	7.3	3.0
Indiana	2.4	15.9	(2)	55.9	49.2	12.7	47.5	12.9	6.0
Kansas	1.3	14.7	20.5	24.2	32.1	5.8	11.7	3.0	3.7
Louisiana	.2	2.8	(2)	59.3	30.5	21.7	25.2	1.7	3.3
Michigan	3.3	7.0	.1	34.4	24.8	5.6	12.3	3.7	13.6
Missouri	.2	38.1	5.8	42.0	39.9	8.8	18.1	2.2	17.6
Nebraska	1.3	13.0	23.1	5.7	37.3	30.1	49.7	8.9	3.4
Oklahoma	.4	56.8	32.4	33.2	50.6	10.4	25.6	14.1	1.7
Pennsylvania	10.0	20.0	(2)	80.0	92.0	2.0	12.0	13.0	5.0
West Virginia	9.0	5.0	(2)	75.9	10.0	.1	34.0	.5	.5
Average	3.4	17.8	13.3	39.2	38.6	9.9	27.2	6.5	8.6

[1] The percentages exceed 100 for individual States and the national average because more than 1 potential use may apply on some areas.

[2] Less than 0.1 percent.

Before this area was stripped, the mining firm planned as part of its operation to reshape and seed the site for this pasture—at no cost to the landowner.

Principles for a National Surface-Mined-Land Conservation Effort

The mining industry, conservation districts, and all levels of government should work together to put practical principles into surface-mining operations at every site:

PREPLANNING.—Make good mine housekeeping and practical restoration measures an integral part of plans for the site—before any mining activity begins. Include a plan for both interim and final land use where practicable.

STABILIZATION.—While mining is going on, take steps to control erosion on the site and on haul roads, including establishing quick-growing plants. Plant permanent cover to protect the area after mining, and reseed or replant where previous revegetation has failed.

STORM-WATER CONTROL.—Plan control of surface runoff on a watershed basis to fit stream capacities and prevent harmful sediment deposits.

WATER QUALITY.—Place highly toxic spoil material only where it can be covered with other overburden or a permanent body of water. Seal off auger holes and any breakthrough to former underground mines. Control drainage from sites and haul roads to keep toxic substances and sediment out of adjacent streams.

WATER STORAGE.—Create as many lakes as practicable, to aid water control and increase potential use of the mined site. Dams and ponds should be designed properly to guard against failure.

AIR QUALITY.—Help prevent offensive noises and air contamination by controlling use of explosives, fire, and motorized equipment.

NATURAL BEAUTY.—Plan operations so they have a minimum impact on the landscape. Make treatment work practical and pleasing to the eye.

HEALTH AND SAFETY.—Take steps before, during, and after mining to minimize hazards from equipment, structures, and water areas.

Mined land should be devoted to the highest and best possible uses compatible with the use patterns of adjoining land and with the geographic location, topography, and other site characteristics.

Information

Those involved in surface mining and restoration of the areas—and those who use the products—must be kept abreast of social, scientific, and economic developments that affect their efforts.

Education in both the program responsibilities and scientific aspects should be fostered by the Federal Government. Universities and colleges provide formal knowledge in this field; the less formal is supplied by trade schools, correspondence courses, field days and workshops, and on-the-job training.

Lectures, field demonstrations, and onsite guidance in solving mined-land problems—the how-to-do-it—would aid in extending new ideas, new methods, and new techniques.

Field trials or tests should be expanded to follow through on basic research in plants, techniques, and methods and to demonstrate their effectiveness. USDA offices located in nearly every county in the Nation can fill many of these information needs in their everyday dealings with local citizens and groups.

Leadership and assistance

Federal and State agencies should make use of experience gained in activities closely related to surface mining as guides to assistance in surface-mining operations and conservation.

For example, USDA has leadership in developing and interpreting soils information and in helping land operators make effective use of it. This information with interpretations specifically for surface-mined land would have great value both in finding potential sources of surface-mine deposits and in restoring surface-mined land to safe, productive use.

Since the problems and opportunities concerning surface-mined land are largely on private rural property, USDA has a major responsibility to provide Federal leadership and assistance in its restoration.

The 186 million acres of National Forest under USDA jurisdiction are managed for mineral resources as part of overall resource management. Since much National Forest land is intermingled with privately owned land, the use and management of one is coordinated with the other to provide maximum private and public benefits.

USDA works closely with private landowners and with State and local governments. Its assistance on private land is channeled through soil and water conservation districts, State foresters, and State and county extension programs. Each conservation district has a program that fits its local problems and is a central source of help in solving these problems. Most surface-mined land is in a soil and water conservation district.

USDA endorses the type of national mined-land conservation effort outlined in these pages. It is a use of the same principles USDA has followed for years in its cooperative work with private landowners. Accomplishments already made by soil and water conservation district cooperators, the mining industry, and Government show that such a program can do the job.

Conclusions

Proper treatment of surface-mined land is an integral part of the total resource conservation effort on private and public land. To this end, USDA recommends as a four-point course of action:

1. *That Federal agencies demonstrate leadership by restoring their surface-mined land.* Each agency managing public land should develop a plan for completing the job within 10 years. Each agency should establish adequate safeguards to prevent harmful effects from surface mining on its land in the future.

2. *That treatment of old mined areas be accelerated.* The Federal Government should participate with States, counties, municipalities, the mining industry, associations, conservation districts, private individuals, and others in developing long-range, comprehensive restoration programs—designed on a watershed or drainage-area basis. Federal technical and financial aid should be on a long-term contract basis.

3. *That to deal with the problem of future rehabilitation of surface-mined land, Federal agencies extend their knowledge and assistance to States and producers of the 50-odd commodities involved.* Technical information should be disseminated as it is developed. Federal agencies should study existing State statutes on mined-land restoration and develop model statutes. The goal should be the blending of knowledge and trust between all levels of industry and government in the interest of mining with a minimum of adverse effects.

4. *That Federal research programs, studies, and field demonstrations be expanded.* Many problems of treating mine spoils have not been solved and many opportunities remain unrealized. Present research efforts are inadequate. The problems examined in this report need specific attention.

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